

The British Research Association
for the
Woollen and Worsted Industries

The Standards of Regain
and the
Possibility of Reform

By
H. J. W. Bliss

with Contributions by
W. J. Hall, H. R. Hirst, A. T. King, Howard Priestman
and **S. A. Shorter**

May 1925

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for the
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I.—AN INTRODUCTION

In the following pages and in the main report which follows will be found an account of the standards of regain for wool, as well as of the practice of "conditioning" and of the faults and difficulties that arise from it. Recommendations are made for the alteration of some of the standards and reasons are given for the proposals. The experiments upon which the recommendations were founded were carried out for the most part by the Association's staff. Thanks are also due to Mr. E. H. Townend, Manager of the Conditioning House, and to a number of members of the Association for advice and statistics upon certain points.

The Serious Losses due to Condition

The main report is necessarily long and detailed and it is wished to explain briefly that it is concerned with the suitability of the standards of regain and particularly with the serious losses connected with the conditioning of yarn. It cannot be too strongly emphasised that damages due to this cause are continually occurring. The examples quoted here, and more fully later on, have been selected because they are striking and because the Association has first hand information about them. £10,000 worth of yarn for South America was ruined completely by mildew. Another lot of 15,000 lbs. weight for the same market, from a different firm and on a different occasion, was badly mildewed. A consignment of hanks, for Japan, was damaged in parts. As an example of another type of fault, 70 pieces made in this country from one batch of yarn were ruined by bars. Again, one manufacturer lost £157 from this cause in six months and another had to "job" several pieces, all quite recently. The list could be extended almost indefinitely, and it may be asked why this state of affairs has been allowed by the trade to continue for so long. It is because these defects do not occur always, but only when the conditions happen to be unfavourable, so that serious though the total damages are, they have not been so constant or so regular as to enforce action. A loss or damage, big or small, occurs but the trouble passes off and, if not forgotten, is shelved. Nevertheless, the figures quoted show clearly how serious the matter really is, though no account is taken of the continual toll of small damages, which must in the aggregate account for more than even these outstanding cases.

The Investigation of Condition

There has long been a suspicion in the trade that some of the present standards of condition or regain were unsatisfactory. There were, however, but few exact data upon which any suggestions for reform could be based. The experience of the Conditioning House and of private firms supplied a good deal of information, but it was naturally incomplete. This was partly because of the difficulty of carrying out lengthy and somewhat tedious experiments under commercial conditions and partly because the necessary apparatus was not available. The Research Association is more favourably placed to deal with records which have to continue for months, and was also able to construct a special room (the "humidity room") in which

the temperature and the moisture in the air could be controlled. Thus a piece of cloth, or of a top could be hung up in an unchanging atmosphere until its weight became constant, or the moisture absorbed by a "dry" top could be compared with one "in oil." In addition, the variations of the air in an ordinary living room (one of the laboratories), and also out of doors, were observed twice daily throughout the year, and samples of material hung near by were weighed with equal regularity. The results of much of this work have recently been published, both privately to members and in the *Journal of the Textile Institute*.

The Proposals for Reform

The proposals may be divided into two parts, namely, that concerning yarn and the remainder (tops, hosiery, cloth &c. &c.). As regards yarn, the position quite briefly is this. Yarn when spun has an average regain of about 13%. If stored or used in an ordinary warehouse, shop, living room, weaving shed, or the like (which is warmed in winter) it will absorb moisture to an average for the year of about 16½%. The trade standard is 18¼%. Thus artificial conditioning, that is the addition of water, is necessary to reach the present standard of 18¼%, unless somewhat prolonged storage in a cellar or unheated warehouse is possible.

Even a standard of, say, 16% would necessitate artificial condition unless the yarn can always be stored for a time by the spinner, commercially a very inconvenient matter. Artificial conditioning is a useless and unnecessary process in itself (except perhaps for some special purposes) and leads to a host of after troubles. Some instances have been quoted and the damages can be grouped generally under the headings of tight picks (fiddle strings), weft bars, cockles, warp-way streaks, mildew and uneven dyeing. It may be repeated that it is quite impossible to calculate the total damages per annum due to this cause. For one actual damage (and there have been many) that we see there must be dozens of minor imperfections. The examples given show that the loss distributed over the trade must be enough to pay over and over again for any temporary inconvenience or extra clerical work involved in a change.

Yarn—The proposal for yarn is, then, that the standard be reduced to 12.62%, about spinners' condition, and equivalent to the present customary charge of 5% for unconditioned yarn. This will involve a minimum of disturbance, and those who are already buying unconditioned yarn will notice no change at all. The details will be given later in the paper. For certain purposes, say for hosiery, where moister yarn may be required, there would be no more difficulty in supplying yarn with extra condition than there is at present in supplying it unconditioned. In such cases, and in fact generally, owing to a gain in transit, yarn would tend to be delivered at *more* than the invoice weight, which is unlikely to cause dispute.

Objections—It must be recognised that no standard could be chosen which would be entirely free from objection, and it has been urged against the proposed standard that both net and tare weights will increase with storage. Alternatives were very carefully considered and the present proposals are made on the grounds that—

- (a) Artificial conditioning should be entirely eliminated. If very carefully conducted it may be satisfactory, but in practice it is only those who give quite exceptional attention to the subject who can obtain regular results.

- (b) The trade is already accustomed to delivery "unconditioned," and a corresponding extra charge.
- (c) For export purposes in particular, the lower the standard within reason the better.
- (d) As regards the net and tare difficulty, this is not avoided by any standard, high or low.

Reference to Appendix B shows that the only possible way of buying and selling correctly is by regular tests for moisture. It has to be accepted that a variation of several per cent. is possible. That such testing is not impracticable is shown by the fact that those who already do it find it profitable.

Other Materials—The other part of the proposals includes recommendations which, while less urgent, are very desirable in order to put the whole matter once for all on a sound basis.

Tops—It has been found that tops "in oil" do not naturally absorb more, but slightly less moisture than "dry" tops. It is proposed that both should be put on the same basis of $18\frac{1}{4}\%$, eliminating an unnecessary and illogical standard.

Union Cloth, Yarns &c., which contain cotton or artificial silk &c. Some of these vegetable fibres do not naturally absorb much more than half the amount of moisture that does wool.

If a cloth containing half wool and half cotton be finished to 16% regain (as for wool) it is much too damp, and the cotton is liable to mildew. Cases of mildew damage to the cotton, for example in cotton warps, are fairly common. It is proposed, therefore, that such goods should be allowed a moisture content proportional to the wool and cotton or artificial silk. This is a new standard.

Woollen Yarns may contain much oil, besides cotton. It is suggested that these should be dealt with on similar lines to union cloths, unless sold to sample. Many countries already have standards. The suggestion is also made that the permissible oil content should be considered. It would be far more satisfactory in the long run for all concerned if waste merchants, spinners and manufacturers worked to a recognised oil content. Uncertainty would be eliminated and the, to say the least, undesirable practice of putting in an excess of oil would be discouraged.

Hosiery should surely be on the same basis as other fabrics, and this is proposed. At present there is no recognised standard. This is unsatisfactory, since many hosiery goods are already sold on a basis of weight. Manufacturer or dyer, buyer or seller should have (as in the rest of the trade) a definite standard for the avoidance or settlement of disputes.

In the main report we will consider in more detail the matter summarised in the foregoing introduction. It is suggested that, quite apart from the proposals put forward, a careful study of the facts will be well repaid. The subject is both of scientific interest and of great commercial importance. It is easy to lose large sums of money by lack of control of moisture content, whether in buying or in selling. Several of the publications of the Association have dealt with this as regards finishing hosiery or cloth and in dyeing. A proper application of those results will enable manufacturers to work to

narrower limits in cloths which are made to a weight, and it is scarcely necessary to point out that at present prices 1%, or even $\frac{1}{2}$ %, of material is of importance.

Conclusion

In concluding this introduction it is submitted that there is an extremely strong case for joint action by all trade organisations to end the present state of affairs. While any change must involve some trouble, the results will be worth it. The "trouble" will be in giving attention to the subject and may be compared with that involved, for example, in quoting in foreign currencies. In a short time everyone concerned will be familiar with the change and business will proceed exactly as before, except that a cause of damages will be avoided.

As the main report is necessarily long, it has been divided into sections. It is suggested that those who cannot study the whole report should first refer to the "contents" and read only the portions directly affecting them.

A number of references are given to the Association's Publication No. 38. This appeared in the *Journal of the Textile Institute*, 1924, **15**, T305.

II.—AN EXPLANATION OF THE TERMS USED*

The *nature of regain* and some of the terms used in connection with it may be briefly explained. Wool, like many other substances such as glue, leather, or wood, absorbs moisture from the air, more in damp weather, less in dry. The amount of moisture absorbed is governed by definite laws and depends chiefly upon the relative humidity of the air.

The *relative humidity of air* is a measure of its "dampness" or "dryness" and is arrived at as follows—The air at a particular temperature is only capable of taking up a certain amount of moisture. If more moisture be present it is as particles of free water in a fog or mist. Generally, the air only contains a part (say 50% or 70%) of the maximum amount possible, and this figure is the *relative humidity*.

But warm air can take up more moisture than cold, so that (although no moisture is removed) heating air reduces its relative humidity, or in popular language, makes the air "drier." Similarly, cooling air increases its relative humidity or makes it "damp." Thus the air in a heated mill is "drier", and has a lower relative humidity than the air outside, and wool stored inside is drier than that stored outside.

In summer, with no artificial heat in use, the temperature and humidity outside and inside are much nearer to one another than in winter. For these reasons wool in a mill which is heated in winter is usually drier in winter than in summer. But in an unheated cellar or shed, wool is moister in winter than in summer. The relative humidity is usually determined by the *wet and dry bulb* thermometer, together with a set of tables from which the humidity may be read.

Standards of Regain—Now because the relative humidity or dampness of the air changes with the weather, therefore the amount of moisture absorbed by wool also changes, and the *same sample varies in weight* day by day and hour by hour. This makes it necessary to fix some definite weight for buying and selling goods made of wool, and therefore *standards of moisture content or regain* have been laid down. The *regain* of wool is determined as follows—The sample is first weighed, then dried by heat and weighed again. The regain is the difference between the two weights and is reckoned on the dry weight. Thus if 115 lbs. of wool when dried goes down in weight to 100 lbs., its regain is 15% (the percentage necessary to *regain* the loss). In this example, if the recognised standard is 18½%, then the buyer has to pay for the difference, viz., 3¼ lbs.

Actually the calculation for invoice is as follows—the allowance on 115 lbs. is 3¼ lbs., namely, 2·826%, and the percentage to be added to the total is therefore 2·826% or, say, 2·83%.

Condition—This word is often used in place of "regain," and "conditioning" means adding the amount of moisture necessary to bring the goods to standard regain. The *Conditioning House* determines the moisture in deliveries and calculates the necessary invoice allowance.

A word of caution may be given here. The word condition is used in two senses. The first is as above, indicating the absorption of moisture. The second is that yarn, tops &c., when stored, not only absorb moisture but also get into a suitable condition for working. Thus yarn may be wild when first spun, but by storage it becomes suitable for weaving. Many, in consequence, consider that the two kinds of conditioning are connected. This is too big a subject to discuss here, but the following note may be made.

Conditioning by adding moisture may possibly sometimes help to bring the material into a good condition for working, but the artificial addition of moisture for this purpose is not usually necessary.

* Fuller details are given in the Association's Publication No. 38.

The Practical Use of Standards—It should be clearly understood that while the standards may, and should, represent average or convenient practice, yet—

- (1) Wool varies from day to day in weight.
- (2) The only ways of producing tops or yarn or cloth regularly to any stated regain, are by—
 - (a) Controlling the moisture in the atmosphere (practised by a few spinners) or
 - (b) By having samples tested frequently and then adding or subtracting the correct amount of moisture, for example, in top making, in yarn conditioning, and in cloth finishing.*
- (3) Unless therefore the above requirements are met, the only correct way of spinning or of buying or of selling is by private (and in case of dispute, Conditioning House) tests of every delivery. All transactions should be in effect on the basis of dry weight. The standard of regain is only a convenient figure, representing an *average* or convenient proportion of moisture.
- (4) The practice of conditioning yarn by the addition of a fixed percentage of moisture does *not produce uniformly conditioned yarn*, though the average may be correct. For the yarn will vary according to the weather on the day of spinning.

Actually the regular testing and adding moisture accordingly is often omitted and "conditioned" yarn is not uniformly at the correct regain.

III.—THE PRESENT AND THE PROPOSED NEW STANDARDS OF REGAIN

Because of the above considerations, *standards of regain* have been adopted in nearly all countries. The seller is allowed by custom to sell a fixed proportion of moisture with his wool, and this moisture is included in his price quotation. In column 2 of the following table the existing (British) standards are given, and in column 3 the proposed new standards.

1 Material	2 Present Standard Regain %	3 Proposed Standard Regain %
Worsted Yarns	18½	12·62
Tops—In oil	19	18½
" Dry	18½	18½
Scoured Wools, All-wool Waste (Clippings &c.), Scoured and Carbonised Noils	16	16
Noils (ordinary)	14	14
Cloth (wool)	16	16
Hosiery (wool)	None	16
Wastes, Cloth, Hosiery—(Containing over 10% of oil cotton or vegetable matter)	Doubtful	See Miscellaneous below
Woollen Yarns or Cloth (in oil)	None	See Miscellaneous below

Miscellaneous—Including Wastes, Cloth, Hosiery, containing over 10% of cotton or vegetable matter. Woollen Yarns or Cloths in oil.

All these materials contain a considerable amount of a substance (oil, cotton, artificial silk) that absorbs less moisture than wool. It is proposed that they may either be sold on sample or the method described in detail in Section V.F. may be followed.

* See Association Publications Nos. 32, 33 and 41.

The method is to determine the percentage of dry clean wool and of dry clean cotton (or artificial silk &c.) in the material. Then the wool is allowed a regain of 16% and the cotton of 8½%.

Thus a cloth containing 60% of wool and 40% cotton would be allowed a regain of $\frac{60 \times 16}{100}$ and $\frac{40 \times 8\frac{1}{2}}{100}$ that is 9.6% and 3.4%. Total regain 13%.

Or again a burry wool or a waste or a woollen yarn is found to contain 40% of dry clean wool. Then the net conditioned weight of the wool is 40% plus $\frac{(40 \times 16)}{100}$ %, that is 40 plus 6.4, that is 46.4%.

Oil allowed in Worsted Tops, yarns and grey cloths should be 3½% "in oil" and 0.634% "dry combed" as at present, see Appendix E.

Oil allowed in Woollen Yarns and grey cloths, shoddies &c.—Without making a precise recommendation it is suggested that the amount of oil in these might be regulated. The question could be conveniently considered at the same time as regain.

Other Animal Fibres—Mohair, camel hair, vicuna &c. (except natural silk, which has its own standard) to have the same standard as wool.

IV.—FOREIGN STANDARDS

As regards the standards in other centres (France, Germany, U.S.A. &c.)—Wools, wastes and noils vary greatly. Tops and worsted yarn are both generally 18½%, but the distinction as to dry tops and tops in oil does not seem to be made in most places. New York, however, puts worsted yarn at 17%. Woollen yarns are standardised at 17% in several centres.

V.—DETAILED REASONS FOR THE PROPOSED CHANGES

It is now necessary to present the full argument for these important proposals. In doing so an endeavour has been made to divide the matter up, so that readers can select such portions as immediately affect them.

A—Objects that the Standards should, if possible, fulfil

To settle satisfactory standards we should first form an ideal to be aimed at. Granted that standards of some sort are necessary, what would be desirable properties for these standards? It is suggested that—

- (1) They should be near to the natural regain of wool in factory, warehouse or shop, so that the material does not need special treatment, and remains approximately correct during handling and storage.
- (2) They should be suitable for the particular purpose to which the wool is to be put. For instance, tops and rovings may be required to contain a certain percentage of moisture for satisfactory working.
- (3) They should be suitable for safe storage and transit.
- (4) They should have a proper relation to one another. For instance, tops dry and in oil, stored in a suitable cellar, should both come to their correct regain.

It is a fact that these ideals are not all completely attainable, but at least most of them may be approached.

B—The present 18½% Standard for Yarn

This fails in every one of the above objects.

- (1) In the ordinary way no yarn ever naturally reaches 18½% regain. As spun it varies from about 10% to 16% and in practice worsted yarn delivered "unconditioned" averages over a long period about 12½% to 13½%. Only by artificial conditioning or by long storage in a damp cellar or unheated warehouse can the 18½% standard be reached. Yarn is not used in such places, but in a warm shed or shop &c.
- (2) Yarn has therefore to be specially treated to reach the 18½% standard, and having been brought to the standard, it generally loses again when handled in warehouse or weaving shed. The average natural regain for a year for yarn in an ordinary room is about 16½%.
- (3) The 18½% standard in itself would be quite suitable for weaving &c., but the practice of artificial conditioning is *the principal cause of several kinds of faults*, largely because irregularities bring parts of the yarn above 18½%.
- (4) The 18½% standard is therefore *not* the best for manufacturing, because it necessitates artificial conditioning.
- (5) In practice many firms are already using unconditioned yarn for weaving quite satisfactorily. If the proposed change is made and a manufacturer still wishes to have artificial condition put on for special purposes it should be at his own risk. Some particulars of the evil effects of artificial conditioning are given below.
- (6) The 18½% standard is not safe for long transit. In practice, export yarn should be "unconditioned," especially for journeys through the tropics.
- (7) The yarn standard of 18½ cannot have any logical relation to the standards for both tops in oil (19), dry tops (18½), and cloth (16).

C—The Damages due to the Artificial Conditioning necessary with the Present 18½% Standard

Consider what may happen when wool is moistened. The subject of "set" (permanent and temporary) has been studied in some of the Association's publications. The facts in brief are these—

- (1) If wool be moistened it is more easily stretched.
- (2) If it be dried while in the stretched condition it becomes temporarily set. It does not shrink again when released (or at least does so very slowly).
- (3) If it then be moistened again, it contracts to its original length.

These facts explain all kinds of variations in the finished piece, according to the exact sequence of operations, for instance—In the backwashing (followed by drying) and throughout the drawing and spinning the fibres are continuously under tension. Any stretching that they so receive is only waiting to be released by a wet process such as conditioning. This effect is quite noticeable with coarse fibres as in lustre yarns.

In winding, or re-winding, the yarn will stretch and will be set to varying degrees, according to the extent and the manner in which it is moistened or allowed to dry.

Conditioning is a moistening process. Any variations in moistening and drying may, and often do, appear in the finished piece as tight places, cockles &c.

The other chief risk of artificial conditioning is mildew. Here again if all the yarn were at $18\frac{1}{4}\%$ and no more, it might be safe. It is the variations that are dangerous, and the higher the standard the greater the risk of reaching the danger point. For the special conditions of tropical export the $18\frac{1}{4}\%$ appears to be definitely dangerous.

Minor imperfections due to the above causes are no doubt far more common than severe damages, but the risk is always present and waiting for a chance set of circumstances, such as a cloth of sensitive design or a slight scamping of the crabbing, or a variation in winding tension.

If all the yarn could be exactly equally conditioned the risks would be much less, but in practice it is not possible to apply moisture perfectly evenly. And in any case, yarn at $18\frac{1}{4}\%$ begins to dry when brought into an ordinary shed, thereby causing some change.

Now take the figures of Firm 5 in Appendix B. In April the variation in moisture content of the yarn as spun was 3.814% . This might easily happen in a few hours with a change of weather. So that *unless the artificial condition is continuously checked and altered* some of the yarn will be very decidedly above the standard.

Damages—It cannot be too strongly emphasised that damages may and do occur owing to the above causes; a few examples have been quoted in the introduction and a more detailed description is given in Appendices G to J. Those who wish for further evidence are asked to refer to these appendices.

D—The Effects of Adopting the Reduced Standard of 12.62%

The outstanding effect of the change would be that artificial condition would be done away with. The result would be that the average condition for the year of yarn *as spun* would be about right (see Appendix B). It would still be advisable, as it is now, to check the condition of deliveries and adjust invoices accordingly. Yarn would tend to be a little above condition in summer and below in winter (when the spinning mill is heated). Yarn would generally gain in weight somewhat during transit. The chance either of getting the yarn dangerously moist or of getting it unevenly moist would disappear and with it the causes of damage already referred to.

Now taking the ideals (section V.A.) one by one—

(1) We cannot devise a standard to suit the conditions both as spun and in the weaving shed or shop.

The average condition for the year of yarn as spun is about $12\frac{1}{2}\%$ to $13\frac{1}{2}\%$.

The average condition for the year of yarn in a dwelling room or shed heated in winter is about $16\frac{1}{2}\%$.

The present standard is $18\frac{1}{4}\%$ and agrees with neither.

Therefore the proposed new standard of 12.62% matches spinners condition, and is about as far below weaving condition as the present standard is above it. And a process is eliminated.

(2) The yarn is suitable for all ordinary purposes, unconditioned yarn is already in common use. It may be possible that conditioning may still be desirable for some special purposes, if so, it can easily be ordered, just as

unconditioned yarn is now ordered. For instance, it may be desirable for hosiery manufacturers who do not add moisture themselves to order yarn "with 5% of added moisture." Storage for a time in a damp or cool place is probably better, however, and has other advantages.

(3) The new standard would be much more suitable for storage, especially for export.

(4) The relation of the yarn to other standards. It is not possible, if other requirements are met, to fix yarn at the same standard as, for instance, tops or cloth.

E—Tops

If reference be made to Appendix A it will be seen that the standards of condition for tops (19% and 18½%) are in very fair agreement with storage in an unheated warehouse or cellar. That is, the average for the year is about right, with considerable variations summer and winter. But instead of tops in oil naturally absorbing more moisture than "dry" tops, they absorb rather less. On this account it is suggested that the 19% standard for tops in oil be done away with and that all tops "dry" or "in oil" be put on the one standard of 18½%. This would bring all the countries of the world into line on the one standard. The following may account for the original adoption of the higher standard for tops in oil—

Tops or yarn in oil are more easily wetted out than if they are "dry combed." If yarn "in oil" be put in water, or the water be sprinkled upon it, it is penetrated readily. "Dry spun" yarn is difficult to wet out, but ultimately wets out just as completely as oiled yarn. But this has nothing to do with the moisture naturally absorbed from the air by storage, since "dry combed" tops or yarn absorb a little more than those in oil.

F—Miscellaneous, viz., materials containing a Mixture of Wool with Vegetable Fibre (Cotton or Artificial Silk) in excess of 10%, and Woollen Wastes, Shoddies, Yarns, and Cloths in Oil.

The first point about these materials is that they do not naturally absorb nearly so much moisture as wool. If such a mixture be stored in a suitable place, so that an all-wool cloth would come to 16% regain (the standard) then—

The oil will absorb very little moisture.

Cotton will come to a regain of about 8½%.

Artificial silk* varies very greatly, the regain of different samples ranged from 8.8 to 16.5% in an atmosphere in which wool would have a regain of 16%. Since these materials behave like cotton in analysis, they will be best reckoned as cotton.

Clearly a wool-cotton union cloth will absorb less moisture than an all-wool stored with it, and many artificial silk blends will behave in a similar way. If now such a union piece is finished to 16% regain (the standard for wool) it will really be much too moist. Very possibly it may feel damp, and in particular the cotton will be too damp. The standard for cotton is 8½% and it has recently been shown (*J. Text. Inst.* 1924, 15, T549) that mildew trouble in cotton does not occur below 8%, but increases rapidly at 10½% upwards. A 50-50 mixture, say a flannel, if finished to anything like 16%, will therefore be particularly liable to damage. The only logical course is to finish such

* The figures were Brand A 15.2%, B 8.8%, C 15.3%, D (three varieties), 16.5%, 9.4% and 13.4%.

a cloth so that each material has its own proportion of moisture. If the right total amount is present the different materials will each take their own proportion automatically. All that is necessary is to determine the amount of wool, cotton (or vegetable matter) and oil. Allow the wool 16%, the cotton $8\frac{1}{2}\%$ and the oil 0% regain. Thus the 50-50 flannel (clean) would be allowed $\frac{50}{100} \times 16\%$ and $\frac{50}{100} \times 8\frac{1}{2}\%$ (that is 8% and $4\frac{1}{4}\%$), total $12\frac{1}{4}\%$. For simplicity, less than 10% of cotton &c. can be disregarded, and artificial silk can be counted as cotton. For the method of determination see Appendix F.

Woollen Yarns &c.

A few remarks may be made on the proposal to adopt these standards for woollen yarns, shoddies, cloths &c. in oil. Such goods are often sold and will continue to be sold by sample. When this is the case, the sample and the bulk can be compared as regards composition of blend and proportion of oil &c. But the net weight of a delivery must include some moisture, and the buyer and seller should have a standard. It may be noted that a standard has been adopted in some foreign countries.

G—Oil Content for Woollens (including Shoddies &c.)

The question then arises as to whether a standardised oil content of, say, 10% for wastes, yarns &c. should not be fixed. (Payment to be made for quantities above or below 10%, as in the case of regain.) This is somewhat outside the scope of the present proposals, but might well be considered at the same time. It may be noted that there is already a limiting oil content for worsted tops and yarns. It certainly seems desirable to have a standard oil as well as a standard moisture content.

The whole question really resolves itself into this, that the buyer and seller should both know the quantity of wool with which they are dealing; the water or the oil are of comparatively little value. If recognised standards were laid down, both buyer and seller would be on a more satisfactory basis, and the possibility of undesirable though not illegal practices be much reduced.

H—Hosiery

This has already been referred to in the introduction. If the desirability of a standard be granted, then hosiery should follow the corresponding woven cloth, for example, a flannel vest and a knitted vest should be sold on the same basis. The proposals for hosiery put this into effect. It may be noted that if the reduced yarn standard be adopted, hosiery manufacturers will find a gain in weight in manufacture, not a loss. For knitting, if they do not add moisture themselves as emulsion, they may for some classes of material require the spinner to add moisture specially. The amount could, of course, be 5% as at present, or less or more (subject to mildew risk).

APPENDIX A

The Natural Regain or Condition of Different Forms of Wool

In this appendix we will consider what is the *natural* regain of wool. If two samples of wool or top or yarn or fabric are taken and one is wetted and the other dried, and they are then stored together, they will in time both come to nearly the same regain. Drying, pressing, finishing &c. alter wool somewhat, so that samples will not absorb quite the same amount of moisture. Still, generally speaking, a set of samples stored together in a cellar will take up about the same regain, and so will another set in a room.

There are two natural ways of storage or of use, viz., in an unheated warehouse or cellar, and in a room that is warmed in winter (a living room, weaving shed, warehouse or retail shop). Usually tops are stored in the former, and yarn is made and used in the latter, and these two circumstances will be considered.

The facts here set forth are taken from the Association's Publications No. 6 (Priestman) and No. 38 (Shorter and Hall)—also published in the *Journal of the Textile Institute*, 1924, 15, T305). Publication No. 6 is chiefly devoted to an examination and analysis of figures relating to a large number of samples of wool and tops stored by the Bradford Conditioning House in an open shed and also in a warehouse. Publication No. 38 records in a more accurate manner the regains of a larger variety of samples in the Association's humidity room, where the atmosphere is exactly controlled. Some other samples were also stored in the laboratory and others in an open shed. These samples were weighed frequently (generally twice daily) to obtain figures for average regain in ordinary practice. The final results of the two papers are in general agreement.

It was found in Publication No. 38 that the average state of the air outdoors in the small open shed throughout that year was 81% relative humidity and 50° F., and the average indoors was 71% R.H. and 60° F., and we can calculate from the results of the experiments in Publication No. 38 the corresponding regain. The method of calculation is given in a note at the end of this appendix.

In the following table then are shown the average state of the atmosphere for a year and the corresponding regain of certain forms of wool.

	Outdoors	Indoors
Relative humidity %	81	71
Temperature F	50°	60°
Tops and Yarns in oil, regain %	19.35	16.85
Tops and Yarns, "dry" combed	19.63	17.02

Priestman (Publication No. 6) found rather higher values outdoors, very possibly because the situation (a shed in the park) was more exposed. His figures (p.9, Condition House samples) were—In oil, tops 20.82, yarn 20.71; dry combed, tops 21.27, yarn 21.12. It will be seen that again the oiled tops contain less moisture than the "dry."

The ordinary conditions of storage in an unheated warehouse or cellar are not so extreme as the "open shed." Particularly in the winter spells of damp foggy weather may result in a great excess of moisture, thus a top in the Bradford series during February averaged 24½% regain (Publication No. 6, p. 8), and an average of 25% for a month was recorded in the Association's experiments (Publication No. 38, p. 17). On individual days even higher results were noted, for example, on 1st January 1924 of 28.96% regain,

and 4th December 1924 of 30.77%. Such figures are not likely to be reached in ordinary storage, and this is confirmed by Publication No. 6, p. 4, where a particular top in the Bradford warehouse averaged 18.35% for the year. We therefore conclude that the "outdoor" figures in the table are somewhat too high and that—*The average natural regain for a top for a year is from 18% to 19%, but that tops in oil absorb rather less moisture than "dry combed."*

As regards yarn, the figures indicate something under 17% as an indoor average. The position selected, however (the Physics Laboratory) is distinctly cooler than a mill, for example a weaving shed. This laboratory also tends to be rather underheated than overheated. Thus the average (morning and evening) for December 1923 was 55.6° F., January 1924 was 57.76° F., December 1924 was 59.30° F. In a warmer place the yarn would be drier and we may conclude that—*The average indoor regain for yarn is not more than 16½% and is probably less.*

Note on the Method of Calculating the Average Regain Outdoors and Indoors

While the figures in Publication No. 38 give an average for temperature and humidity, the number of samples tested for "outdoor" and "indoor" conditions was only small. The bulk of the samples were in the humidity room, where the temperature was constant (72° F.) and higher than in ordinary indoor conditions. It was, however, thought desirable in the present paper to obtain an average from the larger number of samples. This made it necessary to correct the figures for temperature, since wool was found by Schloesing to absorb rather less moisture at a high temperature (and the same humidity) than at a low. The correction is not a large one, so that the general conclusions of the present paper need not be impugned, even should later work indicate that Schloesing's figures are not final. The following method (due to Dr. Shorter) was therefore adopted in calculating the figures already given.

The data given in Publication No. 38 (first part) refer to one definite temperature (72° F.). Now for a fixed relative humidity the equilibrium regain of wool varies slightly with the temperature—the mode of variation (an increase of regain with the decrease of temperature) being characteristic of all textile materials. To apply the results of Publication No. 38 to other temperatures it is necessary to correct for the temperature difference. There are two sets of results available for the purpose of making this correction—those of Schloesing and those of Hartshorne. It is shown in the second part of Publication No. 38 that the former are much the more reliable, and in fact conform in a highly satisfactory manner to a certain test. In the following table are given the values (calculated from Schloesing's data) of the increase of regain (%) produced by a decrease of temperature (at constant relative humidity) of 1° F.

Regain %						Increase of Regain per degree F decrease of Temperature	
19	0.053
18	0.051
17	0.048
16	0.043
15	0.041

Some Additional Tests on Tops and Yarn

It was considered that some of the figures should if possible be put on a rather wider basis. Another set of samples was obtained and tested, not through the whole range of humidities, as in Publication No. 38, but at one

humidity. The object was to ascertain if the previous figures represented average tops, and whether the tops were in a normal state after their exposure to the range of humidities in the room. The new samples were tested in an atmosphere of 70% relative humidity at 72° F. They were also tested after being rolled in wet cloths overnight, in order to remove the influence of drying in the backwashing machine. In each case they were kept in the humidity room till they had settled down to constant weight. The results are given in the table below, together with the corresponding regains of the tops used in the investigation described in Publication No. 38.

Regains at 70% Relative Humidity and 72° F.

Sample	Tested as received	Tested after wetting in cotton cloth
80's Australian	15.31%	16.00%
Warp 64's	14.86%	15.79%
Weft 70's	15.41%	16.21%
Warp 70's	15.25%	16.45%
Cape Warp... ..	15.04%	16.34%
Warp 60's	15.71%	16.86%
60's M.V.	15.61%	16.76%
70's Australian	15.89%	16.43%

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80's Botany	16.00%	—
56's Sydney	16.00%	—
Yorks. Hog	15.60%	—
Cape	15.40%	—
Mohair	16.00%	—

The regains of the latter samples lie between the two sets of figures for the new samples and may therefore be regarded as representative. It will be observed that in every case the wetting process has resulted in a restoration of regain. A study of this subject appears in Publications No. 33 and 41.

APPENDIX B

The Regain of Yarn as delivered Unconditioned

A good deal of yarn is at present delivered unconditioned, either because so ordered by manufacturers or for export &c. As the customary basis of transactions is a regain of 18½%, the spinner has to charge extra for drier yarn.

It will be noted that the percentage to be added to the invoice is not exactly the same as the deficiency in regain. Thus let the price be 100d. per lb. and take the figures of Firm 6 below. Now 100 lbs. of perfectly dry wool, correctly conditioned at 18½% weigh 118½ lbs. and at 100d. are worth 11,825d. But the firm sell the yarn drier than this and charge 7% extra. Their invoice will provide for—

$$\begin{array}{rcl} 110.514 \text{ lbs. at } 100\text{d.} & = & 11,051.4\text{d.} \\ \text{Add } 7\% \text{ for condition} & = & 773.6\text{d.} \end{array}$$

$$\hline 11,825.0\text{d.}$$

Their yarn is at 10½% condition, that is 7¾% short, but the invoice charge is only 7%.

The commercial figure for delivery unconditioned depends chiefly upon—
(a) The atmospheric humidity of the spinning room. (b) The humidity of the place of storage prior to dispatch. (c) The length of storage. It is clear that where yarn is stored for any length of time after spinning it will gain moisture.

It is found that an all round **addition to the invoice of 5%** for unconditioned yarn works satisfactorily. This represents the average, taking the year round, though there may be considerable variations according to the weather &c.

An invoice charge of 5% corresponds to the new standard 12-62 regain which is recommended.

The following are records from various spinners showing how much they charge in this way, or how much their yarn is below the standard.

Records of Firms

Firm 1—Charge 5% extra on invoice for unconditioned yarn.

Firm 2—5% charge. Two or three hundred thousand weight were spun on commission during the war and delivered unconditioned. The spinning was at different times of the year; 5% gave a normal result as regards yield on this large weight.

Firm 3—5% charge. Yarn if conditioned and stored at 18½% loses weight unless stored "in a very suitable place."

Firm 4—5% charge. Yarn as spun, if placed in the warehouse basement, gains 1½% in a week. Spinning calculations—All yarns are spun 5% light to allow for condition.

Firm 5—Subjected unconditioned crossbred yarn to *Conditioning House Tests during 1923-1924.*

Month	No. of Tests	Average	% Allowance on Invoice	
			Maximum	Minimum
January	7	5.366	6.310	4.365
February	6	5.371	5.564	4.553
March	8	5.573	6.537	4.845*
April	9	5.382	6.691*	2.877*
May	12	4.537	5.853	1.848*
June	9	3.706	4.421	3.148
July	11	4.339	5.320	2.941*
August	3	3.839	4.257	3.683
September	4	4.674	5.783*	3.965*
October	5	4.091	4.668*	3.441*
November	7	5.406	7.230*	3.706*
December	8	5.814	6.901	5.507

* Twofold yarn.

Average of monthly figures—November to April, 5.485%; May to October, 4.197%.
Average for the year, 4.841%.

This firm charges only 4% extra for unconditioned yarn. They also report that the deficiency of regain is down to 1% after storage in the cellar for a time, i.e., the yarn in their cellar will slowly come up to 17% regain. The difference between summer and winter (when the mill is heated) is very noticeable. In this series of records twofold yarn gave the only four figures below 3% and the only figure above 7%.

Firm 6—This firm keep the humidity of the spinning room down as nearly as they can to 11° bulb difference (rather drier than the usual), and claim 7% on an unconditioned yarn *delivered direct from the frames*. If yarn is standing for any length of time waiting delivery in the wet room then it is tested and charged according to its actual regain. The invoice charge of 7% corresponds to a regain of 10½%, as already explained. Now a bulb difference of 11° corresponds to a regain of about 13%. This is interesting and agrees with an observation recorded by Priestman in Association Publication No. 6, p. 5. The fact appears to be that yarn as spun is actually

drier than the moisture in the atmosphere would indicate. No doubt the warmth of the running machinery, and the heat generated by friction in drawing &c. accounts for this.

Firm 7—The mill is humidified. Yarn in oil at the reels is 3% dry. Scoured yarn is finished to the correct standard. Yarn in warehouse (no sunlight, nor artificial heat, nor draught) over a period, averaged about the present standard 18½%. (This is a hosiery firm; both this and another hosiery firm appear to take special care to have their yarn up to the 18½%.)

Firm 8—Both their own and bought yarns (unconditioned) average 12% to 14% regain. All bought yarns are tested for moisture and oil. The purchase and sale of yarn unconditioned is on a 5% allowance. Yarn when stored gains 2% to 4% in two to three weeks. Yarn in transit from the spinner gains 1% to 1½%.

Firm 9—Tops started in the drawing at 19% give yarn at about 13% (4.6% to 5.6% light).

Firm 10—A firm of manufacturers who test deliveries regularly found the following average results from three spinners, the tests extending from June to February, 1924-5. The figures given would be the *correct* average extra charge on invoice, in place of 5%.

Spinner A	...	...	...	...	4.677%	on 125 tests
" B	...	...	...	...	5.032%	" 71 "
" C	...	...	...	...	4.772%	" 31 "

In this case (as in the case of Firm 5) the yarn was moister in the earlier (summer) months, viz., correct average charge, A 4.56, B 4.46, C 4.85. The variations are also noticeable, the figures for individual tests ranging from 2.88% to 8.25%.

Conditioning House

By the courtesy of Mr. E. H. Townend the following figures are available. Owing to the fact that the Conditioning House does not receive information as to whether yarn is conditioned or unconditioned, it is not possible to be certain to which category a particular test belongs. We may assume, however, from the tests of Firm No. 5 above, that unconditioned yarn will very rarely give less than a 2% charge on invoice. No figures below 2% are therefore considered. The Conditioning House figures for a year's tests, presumably mostly unconditioned, come out as follows—

Addition to Invoice						Number of Tests	
Between 2% and 3% ...						Twofold	Single
Between 2% and 3%	...	...	...	...	...	248	131
" 3% " 4%	...	...	...	...	...	205	114
" 4% " 5%	...	...	...	...	...	145	73
" 5% " 6%	...	...	...	...	...	95	41
" 6% " 7%	...	...	...	...	...	14	6
" 7% " 8%	...	...	...	...	...	13	3
Over 8%	...	...	...	...	...	6	4

Reckoning the tests between 2% and 3% as 3½%, and so on, and working out the average, we get the figure 3.8% average for twofold and 3.2% average for single. This is less than the amount indicated by spinners' experience, and two factors may be expected to contribute to this, viz.—That some of the lower tests (2% to 3%) may probably be of conditioned yarn that has dried somewhat, or that was insufficiently moistened; and that unconditioned yarn may have picked up moisture during storage,

packing &c., before reaching the Conditioning House. There is evidence for this in some of the spinners' reports already given. On the whole it may be concluded that—

- (1) The proper charge for unconditioned yarn in ordinary mills on the $18\frac{1}{4}\%$ standard varies from 2% to 8%, sometimes more according to the weather.
- (2) That the average is not quite 5%.
- (3) That the proposed new standard of 12.62 regain (which would correspond to a 5% charge on the old standard of $18\frac{1}{4}\%$) would be close to the average of unconditioned yarn, as packed by the spinner.
- (4) That whatever standard is adopted the only correct method is to test frequently and adjust charges accordingly, as is already done in some cases.

APPENDIX C

The Regain of Wool in Top Making, Combing, and Drawing &c.

The following is information collected from top makers and spinners—

Firm 1—Combed tops which start at the standard regain of 19% are down to 14% or 15% at the end of the drawing and to 13% at the end of the spinning. They say, "If these (crossbred) tops were standardised at a lower regain they would not draw so well."

Firm 2—The standard condition works well, but they like new tops, if anything, moister.

Firm 3—Long wool for combing should be at 23 to 25% after scouring, botany 21 to 23%. Loss in the comb, $3\frac{1}{2}$ – $4\frac{1}{2}\%$. For making tops to the correct regain the addition of moisture in gilling is relied on—not storage in a cellar.

Firm 4—*Tops in oil* come to 19% in their top store, which is satisfactory. Drawing is started at 19% regain, but the latter is down to 14% at the end of drawing and 12% after spinning. Tops "dry combed" are started at $18\frac{1}{4}\%$ regain and are down to $14\frac{1}{4}\%$ in the drawing and $12\frac{1}{4}\%$ after mule spinning (with humidification).

Firm 5—This firm prefer the wool damp after scouring in the case of Botany, but not for longwool. About 6% moisture is lost in the comb. The tops are brought up again by the addition of moisture in gilling—not by storage.

It will be seen that there are considerable divergencies of opinion as to the amount of moisture really necessary.

APPENDIX D

The Weaving of Unconditioned Yarn

There does not appear to be any difficulty. There are two points which may require watching if the change is made. Unconditioned yarn is slightly "stronger but less elastic" (see Firm 3 below). Some slight adjustment of warp tension may therefore be required in exceptional cases. It may be

noted that in the case of delicate sized warps this consideration will not come in. The sizing completely neutralises any effect of previous conditioning. There is also some evidence that unconditioned yarn may occasionally "take up" or shrink to a slightly different degree as compared with conditioned yarn, and that pieces may come up a little heavier. The change from conditioned to unconditioned would therefore have to be watched in the same way as a change in lot or quality or from one spinner to another.

Hosiery

There is a preference for conditioned yarn. It should be noted, however, that (a) much hosiery yarn is specially moistened (lubricated with an emulsion) by the hosiery manufacturers themselves, (b) as already explained, there would be no difficulty in supplying specially conditioned yarn if required.

It may be well to repeat that conditioning (by moisture) must not be confused with conditioning in the sense of getting the yarn into a suitable state for weaving, which is best effected by storage. The two are not necessarily connected, though moistening followed by drying and steaming or heating have all been used in various ways to reduce snarl.

Firm 1—Conditioned yarn was woven for a period simultaneously with unconditioned. There was absolutely no trouble except that the pieces woven from unconditioned were apt to come up a little heavy, although of course the spinners had allowed for the difference in calculating counts.

Firm 2—Yarn up to 2/36 worsted woven unconditioned. No trouble was experienced even when the yarn was woven the day received from spinner, who was known not to have stored it for more than 24 hours. Records extending over 100 pieces showed that the pieces from unconditioned yarn came up about half yard shorter. The yarns were, however, from different spinners.

Firm 3—Unconditioned yarn is rather stronger but rather less elastic. For weft, unconditioned yarn is an advantage. In storage it is less liable to mildew. Pieces made from unconditioned yarn show less faults as regards unevenness.

APPENDIX E

Methods of Determination and Analysis

There are several determinations that are in common use both privately and by the Conditioning House.

- (a) The yield of greasy wool after a "commercial scour" and the percentage of oil and soap in tops, yarn &c.
- (b) The amount of moisture or regain in a sample.
- (c) The amount of cotton or vegetable matter.

In such determinations the precise method of sampling and carrying out the test may affect the results. Therefore standard methods should be laid down specifying for example the composition and strength of soap solution and the temperature. It is suggested that a committee of experts be appointed to draw up precise specifications for incorporation in any new regulations.

APPENDIX F

Miscellaneous Materials. Detailed Particulars of the Tests and Calculations for the New Standards

It should be noted that most of the tests are not necessary where the composition of a material is known. For example, a manufacturer sells and a buyer buys a 50-50 flannel. The proper regain and hence the proper net weight can be calculated at once. Only in the event of dispute as to whether the material is actually 50-50 or, say, 40-60 does an analysis become necessary. The products under this heading all contain some considerable proportion of a substance besides wool, causing very wide variations in natural regain. For example—

Oil (natural regain very small).

Dirt (natural regain may be nothing).

Cotton (natural regain about half that of wool).

Wool fat and suint (natural regain extremely variable).

Usually these goods are sold on sample. If sold to specification the procedure given below will give a result very near to commercial practice, but not all the determinations will be necessary in most cases. Determine—

A. The weight of the sample as received.

B. The dry weight of the sample.

C. The dry weight of the sample after a "commercial scour" (if oil and dirt be present).

D. The dry weight of the cotton or vegetable matter present, if any.

Then C minus D is the weight of dry wool. Allow 16% regain on the wool and 8½% on the cotton in mixtures.

E. *Wool, net weight*—Then the net clean weight of wool at correct regain is $(C-D) \times \frac{116}{100}$

F. *Cotton, net weight*—And the net clean weight of cotton is $D \times \frac{108\frac{1}{2}}{100}$

G. *Mixtures, net weight*—The net clean weight of wool-cotton cloths or yarns is $(C-D) \frac{116}{100} + D \frac{108\frac{1}{2}}{100}$

Oil Content

If the suggested 10% standard for woollen yarns be adopted then the exact value of the yarn can be calculated from the same data. The formula is not inserted pending a decision on this point.

APPENDIX G

Damages due to Artificial Condition. A Note on Appendices H, I, J

It will be seen in the following appendices that faults due to artificial condition are common enough. At the risk of unnecessary emphasis it may be repeated that the principal defects are *mildew*, resulting in damage ranging from complete rotting to slight inequality in dyeing, *alkali migration*, which contributes to mildew and to uneven dyeing, and *uneven extension of the yarn*, resulting in a variety of defects in the fabric.

There is one point that calls for some explanation. It may be asked why, if a fault occurs in one piece, it does not on another that has had the same (apparent) treatment. The answer seems to be that if all yarn could be exactly and evenly finished to $18\frac{1}{4}\%$ regain, there would be much less risk. But actually we have a number of chances to deal with. Some of the yarn may be moister, it may lie a little longer, the weather may be hotter, the yarn may be wound under greater or less tension, the particular cloth structure or the dye used may be particularly sensitive, or the finishing processes less perfect. *Damages often, perhaps, usually happen when more than one such factor is in operation*, and therefore most pieces escape. This accounts for the fact that it is difficult to *make* faults intentionally by conditioning. Success has sometimes been attained, but more often failure. No example could be clearer than that of the 70 pieces mentioned below, yet hundreds of pieces go through without trouble.

It is worth taking just one example of the sort of variation that may occur. Examine the figures of Firm 5 (Appendix B) already referred to. In May one lot of yarn was 5.853% deficient in moisture, another was 1.848% , a difference of 4% , due no doubt to the weather and other variable causes. Suppose the conditioning arrangements were set to bring the first lot up to $18\frac{1}{4}\%$, and the second lot then came along. *This second lot would come out at $22\frac{1}{4}\%$, much too moist*. No doubt this would soon be noticed and corrected, but this is just one of those chances where the "human element" comes in, and where mistakes may occur.

APPENDIX H

The Effect of Moisture Content on "Mildew"

The development of so-called mildew, which is a general term for the growth of moulds or bacteria, or both, on wool or similar fabrics, has been shown in Publication No. 23, page 8, to be dependent on the amount of moisture present in the wool. We found that wool must be just moist (exposure to a saturated atmosphere may be sufficient) before bacterial action takes place. In the course of our consulting work we have had many types of mildewed wool material submitted to us. And, with the exception of those examples which have definitely occurred in one of the wet processes of finishing, most of the faults have been traced to conditioned yarn.

Yarns may become damaged in two ways. Either immediately following the conditioning process or during storage after being conditioned. In the first instance, it is well known that it is impossible to treat yarn by any of the commercial processes, so that it is evenly moistened, with the result that mildew may develop on the wetter portions. Numerous examples of "dyeing faults" have been traced to such causes. Secondly, as regards damage during storage. We have had at least three lots of yarn submitted to us which have become almost completely disintegrated during sea voyages through the tropics. In two cases the yarn had been shipped to South America and in another case to Japan. All the lots had been artificially conditioned to the standard regain. It is obvious that the higher the standards of regain the greater the chance for portions of bales to become locally saturated with moisture, owing to currents of the air surrounding the fibres, set up by variations of temperature in the bale itself, or by external causes. For instance, a bale near a boiler room partition, or near the sunny

side of the ship may easily reach very high temperatures. The heat may drive the moisture to a cooler portion of the bale, and we have the ideal conditions, warmth and excessive moisture, for mildew. In the Japanese example quoted, individual hanks or portions of bales were damaged, and it is not unreasonable to suppose that some change of the above kind occurred.

Examples

(1) A spinner sold 15,000 lbs. of medium crossbred yarn to a yarn merchant for export to South America. The yarn was delivered on cheeses, and the export merchant insisted that the yarn should be spun very accurately to the counts required. As the deliveries were made in very hot summer weather the spinner was afraid to put in the full amount of moisture corresponding to the standard 18½% regain, and therefore sent in his first deliveries light in condition, that is containing less water. The yarn merchant on reeling the yarn complained about light weight and insisted on the yarn being delivered in the standard count. The spinner carried out the instructions accordingly and completed the order fully conditioned. The yarn was held up at the port by a dock strike in extremely hot weather, and when the cases were opened the whole of the consignment was found to be badly mildewed.

(2) A consignment of hanks to Japan had a very similar history to the last, namely, that the purchaser insisted on the full weight, and that a number of hanks in some of the bales were damaged.

(3) A consignment, we understand about £10,000 worth, was sent to South America, conditioned, on cheeses. The cheeses were damaged by mildew in rather a curious manner, locally, so that although the bulk of the yarn on the cheese was sound, it broke continually in rewinding, almost as if it had been moth eaten. The consignment was spoilt.

APPENDIX I

Dyeing Faults due to Artificial Conditioning

Apart from the structural damage suffered by the fibre through bacterial action, referred to in the preceding section, the affinity of the fibre for dyestuffs is greatly modified. On the one hand mould growth on fibres causes a resist effect towards dyestuffs and on the other bacterial action produces alterations in the dyeing property, even though structural damage may be scarcely apparent. A full account of the effects produced with various types of dyestuffs, with a number of examples of commercial dyeing faults traced to this cause, is given in Publication No. 24. Further, the uneven application of moisture results in uneven distribution of the alkali content of the yarn as shown in Publication No. 25. This may cause uneven yellowing on exposure. Moreover such differences in alkalinity are not easily levelled up on scouring, and as the effect of tentering or any steaming process is to yellow the wool, and alter its dyeing affinity in proportion to the amount of alkali present, uneven dyeing results. These points also are fully discussed in Publication No. 25. It is difficult in cases of stains due to this cause to be sure at what stage the mildew caused the damage, e.g., whether by conditioning the yarn or in the wet finishing processes.

- (1) A large white wool-cotton flannel blend came up irregular in shade when dyed delicate colours. The difference was found to be due to mildew and the only process in which it seemed possible for this to occur was in conditioning the yarn.
- (2) A tweed showed stains, thought by the manufacturer to be due to oil. Examination showed that individual strands of the yarn were mildewed. The mildew therefore occurred on the bobbins.

Numerous other cases have been seen, including damage to cotton warps &c. &c.

APPENDIX J

Some Defects in Shrinkage due to Uneven Condition and Artificial Conditioning

It is now pretty well known that irregular shrinkage of either warp or weft in a cloth may be caused by five entirely different factors.

- (1) Variation in the number of picks per inch in the cloth.
- (2) Variation in the number of turns per inch in the yarn.
- (3) Uniform twist in yarn which varies in its diameter.
- (4) Differences in quality.
- (5) Variation in the condition of the yarn.

Cockles—In every attempt to ascertain the true cause of cockling it must always be remembered that more than one of these factors may be present at the same time, and it is also true that one of them may affect another. For instance, weft that is too wet and that has been stretched in winding will also show a reduction in the number of turns per inch.

Fiddlestrings—The commonest of all faults due to condition is that which is known to many people as "fiddlestrings," namely, tight picks or portions of picks. This fault may originate in two ways, but the general cause is the uneven application of water on the machine that winds the yarn on to cheeses. This may be due to the fact that the conditioning roller is greasy and that therefore the water does not adhere uniformly to its surface and that in consequence some of the threads pick up more moisture than others, or pick it up to a different extent at different times. There are then several possibilities of accident. First, if the yarn is being wound under heavy tension it will actually be stretched between the conditioning roller and the frame, the distance from one stretched place to the next varying greatly. Secondly, if the tension in the cheesing frame is very light, there is still every possibility that when the yarn is rewound under heavy tension on to pirns that the damper places will stretch more than the dry ones, with consequent faults, due to such variation, in the cloth. Thirdly, we have absolute proof that yarn which varies very greatly in the amount of water that it contains at different points along its length may be stretched in the loom itself, if there is heavy tension on the yarn in the shuttle.

Laps on Conditioning Roller—But the majority of faults of this kind are due, not to the greasiness of the conditioning roller, but to the presence of laps upon it. It is obviously impossible to prevent fluff and other kinds of fly getting into the water of the trough, and if above a certain amount accumulates in the water, this fluff will cling to the rollers and fasten itself round them in the form of a lap, which is of course as fully saturated with water as a sponge which has been dipped into a basin. If there is a lap

near to a point at which thread crosses the roller (the end traverses to and fro), such thread will naturally bump into the lap and absorb extra moisture once every time the drum makes a revolution. In that time, yarn equal to one circumference of the drum will have been wound on to the cheese, and if it is a 12 inch drum (as is common), the tight places will be separated from one another by $37\frac{1}{2}$ in. This fault can therefore always be detected by the very simple expedient of measuring the distance along the yarn from the centre of one tight place to the next. As was the case in the other type of unequal conditioning, the stretching may take place in the drum winder itself, if the tension on the yarn is heavy, but it is also true in this case that if the yarn is to be used for weft it must go through some other type of pirn winding, where the drag is always heavy. If then the yarn is rewound before the condition has distributed itself uniformly through the cheese, each original damp place will then be stretched out of all proportion to the dry yarn adjacent to it.

On account of the reasons set out above, it is fair to conclude that whenever tight places are separated from one another by $37\frac{1}{2}$ inches, the fault was originally caused by a lap on the conditioning roller of the frame. Nearly all spinners know that this is a serious defect and they invariably give orders to their winding managers to see that laps are never allowed on the roller. In spite of this fact, laps do occur and are removed by the employees without being discovered by the management. On at least two occasions, when spinners have declared that such a thing never occurred in their places, a visit has been made to the machines and laps found in exactly the places where they would naturally be expected. Much more than this may be said. The fault is one which so easily occurs that it is unusual to find a room full of winders in which there is no trace of a lap on some of the rollers.

Experiment on Effect of Lap—If anyone is doubtful of the truth of these statements, it is quite easy for him to prove how far they are correct by a very simple experiment. Let a little bright coloured, say, green ink be mixed with the water in the conditioning trough of a winding frame and let a lap be purposely lain on to the roller adjacent to some end. The moment a cheese begins to wind, it will be found that one end of it is absorbing so much more moisture than the rest of the yarn that that end of the cheese is bright green in colour, although the rest is absorbing so little moisture from the bare metal of the roller that it is not visibly altered in colour. If the yarn is then unwound, the distance from the centre of one green place to the centre of the next will correspond exactly with the circumference of the drum on which the cheese is built.

Effect in Cloth—Whether the yarn has been stretched on the drum winder or stretched when winding it on to pirns, the result in the cloth will be exactly the same. The wetter portions of the yarn being more elastic will be much more stretched than that which is normal, and when the yarn dries in the course of a day or two, the stretched portion is automatically "temporarily set" in a very extended condition. (Publication No. 12.) The grey cloth will appear to be entirely normal; nothing shows in the grey, but as soon as the piece is wetted in any of the finishing processes, the stretched portions of the yarn endeavour to revert to their original length, and in so doing contract, thereby pulling themselves perfectly straight and producing what are known as "fiddlestrings."

Effect of Twist—Although it has nothing to do with the present discussion, it is also true that "fiddlestrings" may be caused by uneven twist, but in that case each hard place must necessarily contain anything from 30 to 50 per cent. too many turns. On the other hand, where yarn has been stretched in the winding, similar tests for twist will show that there is less twist in the tight places and that the two causes may therefore be very easily distinguished from one another.

Conditioning Spools—As already stated, "fiddlestrings" may also be due to condition very unevenly applied to the outside of a spool. If the outside is wet and the inside is dry and there is very heavy tension in the shuttle, each time the yarn runs to the bottom of the build on the spool, the wet place will be unwound and that wet place will stretch as it is going into the cloth.

Steaming—The same fault may occur if the yarn has been steamed and dried on the bobbin. In that case the inner portions of the yarn may be wetter than the outside. They will likewise stretch in the loom and they will be separated from one another by exactly the length of yarn which can be found in unwinding one complete traverse up and down of the twist frame lifter. This class of fault is the only one in which it has been the good fortune of the writer to diagnose the trouble and also to go to the mill and find the cause of trouble still present. There are a good many other forms of fault which can only be due to water, which have never yet been really bottomed, for the very simple reason that operatives nearly always discover them before the management sees them, thus making it impossible for anyone to say with absolute certainty that any particular form of accident had taken place.

Storage on Damp Floor—Uneven shrinkage of a very serious character was once traced to some unconditioned cheeses which had been packed in bags and left lying on a damp floor. They were so arranged that one end of every cheese had one damp end and one dry end. In this case not only was there serious alteration in shrinkage, but mildew was set up to such an extent that a pattern appeared in the cloth on account of the brownness of the yarn, due to mildew.

Lustre Yarns—Of this type of fault the most common of all is that due to the conditioning of lustre and demi-lustre weft. As a rule no spray or damp cloth or damp floor is ever allowed to touch the yarn itself, but on the other hand, it is so susceptible to the action of moisture that several faults are liable to result if it is allowed to absorb anything like the present trade standard of moisture for yarns (18½%). In this class of material a very slight variation in condition or a difference in the length of time the yarn has been in the cellar will entirely alter its inclination to shrink, and in a piece, one bobbin will differ from its next door neighbour and cause very serious cockling. But an even worse fault is likely to arise by reason of the fact that different fibres in a demi-top will shrink to different extents with the same amount of moisture. Why this should be particularly obvious in yarn which has been spun as far as it will go, it is very difficult to say, but any yarn of this character, if conditioned at all, may develop loops or curls of a character that will make any piece unsaleable. In a case of this kind, if a few fibres lying close to one another in a thread shrink 10% more than the rest of the fibres in that section, they will naturally pull the other fibres

into a curl, and when these fibres are singed off in the finishing of the cloth a tuft of burnt ends will form a slight rosette on the face of the fabric. Although this fault does not properly come under the head of those which are due to applied moisture, it is one which offers strong argument in favour of a reduction in the percentage of moisture which should be allowed in the trade. Cockling of this description may be complicated by the use of two tops in any drawing, if these two tops do not happen to possess exactly the same shrinking power. In such a case it is very difficult to say where the action of condition begins or ends, but it is obvious that when variation in condition is present in yarns of such a character, almost anything is possible in the way of slack and tight bobbins.

Since the above was written the author has been able to conduct further practical experiments, with the object of making some of these faults. The results are not yet complete, but so far as they go, entirely confirm what has already been said.

With regard to the above, the following are some examples of which the Association has the exact history—

(1) The yarn was required quickly. The spinner two-folded it, conditioned it, cheesed it and delivered it all within a day or two. The manufacturer wound it for weft and wove it at once. Result, two or three pieces of medium botany worsted were quite spoilt by tight picks or portions of picks, known as "fiddlestrings."

(2) An exactly similar history with another manufacturer (fine botany), who had the trouble twice in six months, and sustained losses of £112 and £45 respectively.

(3) A manufacturer bought 20,000 lbs. of two-fold medium crossbred yarn from a spinner for weaving, the warp and weft being the same in count and twist. All the yarn was delivered on cheeses, as the manufacturer was making his own warps and winding his own weft from cheeses. At the spinner's suggestion the cheeses for the weft were not conditioned, but the manufacturer finding it inconvenient to have two kinds of cheeses, gave instructions to the spinning mill that no more unconditioned cheeses were required, and in accordance with his instructions the deliveries were continued with conditioned cheeses only. The member of the spinning firm who had the matter in hand was away at the time and, on his return, fearing that the manufacturer might be winding his weft from conditioned cheeses, made inquiries and found that this was the case and insisted on the weft cheeses for the balance of the order being delivered with unconditioned yarn. The final result was that the manufacturer had 70 pieces ruined by "fiddlestrings" made from the weft which had been woven from the conditioned yarn.

(4) The following is contributed by a well-known "white" finisher. For many years the dyer and finisher of worsted and woollen goods has been subject to great loss by reason of cockles, weft rows, warp streaks &c., particularly in worsteds. The British Research Association has now definitely ascertained that one fruitful cause of these and similar faults is "artificially conditioned yarn." It has also been proved that mildew, stains, uneven dyeing &c., can in many instances be traced to the same cause. The efforts of the dyer and finisher to combat these defects have resulted in serious increases in working expenses and diminished turnover, which have naturally caused dyeing and finishing prices to be higher than would be the case

if these abnormal defects were eliminated. The "white" trade is one that is perhaps more sensitive to this class of defect than any other, and it is the experience of a stover and bleacher of 30 years' standing that every working day of that extended period has revealed many faults, which can now be clearly traced to conditioned yarn. The aggregate results throughout the dyeing and finishing trade of losses incurred in dealing with this class of defects must be enormous, and to this aggregate must be added the losses sustained by makers and merchants when selling these defective goods.

(5) As an example of many minor cases where suspicion becomes nearly a certainty, a fine fancy worsted came up with dark lines or narrow bars weft way. On examination this was found to be due to a variation in the tension of the weft throwing the warp up to the surface to different extents. The appearance of the fault was similar to that shown in Publication No. 7, to be due to a regular variation of twist. This variation of tension, judging by many similar examples, is due to the conditioned yarn being unequally stretched, either in winding or rewinding.

APPENDIX K

The Commercial Effect of the proposed New Standards and Draft Notice

Worsted Yarn—The most important change proposed is the reduction of the yarn standard from 18.25% to 12.62%. Under the old standard 100 lbs. of dry wool is sold as 118.25 lbs. Under the new standard 100 lbs. of dry wool would be sold as 112.62 lbs. The simplest way of showing the difference is by an example. Let the old price be 100d. (8/4) per lb. Then 118.25 lbs. are worth 11,825d., and contain 100 lbs. of dry wool. Under the new standard we still have 100 lbs. dry wool, but the conditioned (selling) weight is only 112.62 lbs. The total value is still the same, namely, 11,825d.

Therefore the new price is $\frac{11,825d.}{112.62} (=104.9991) = 105d. \text{ per lb.}$

Therefore the prices under the new standard would be 5% more per lb. (This is the same as the charge usually made now for "unconditioned" yarn.)

Similarly, without going into the detailed calculation, the nominal count of an identical yarn would be 5% higher. For instance, 2/40's (old standard) become 2/42's (new standard).

Tops in Oil—Reduction of the standard from 19% to 18½%. In this case the only effect would be to raise the price per lb. by 0.63%.

Other New Standards—The other new standards will not necessitate any change in present quotations, but will put several classes of goods on a more satisfactory basis as regards disputes &c.

Notice and Date of Change—If the new standards are agreed to, a notice or circular something like the following will be necessary—"By agreement between (list of federations, chambers of commerce &c. &c.), the standards of regain or moisture content in goods made of wool and delivered on and after (date) will be as follows. In the absence of special agreement to the contrary, all new transactions by members of the above bodies will be assumed to be on the new basis." (Here would follow the table of standards.)

Existing Contracts. Worsted Spinners—

A—Notify customers that in the absence of instructions delivery of running contracts will be on the new regain, viz., 12.62% regain, and 5% extra charge on invoice.

B—If the old regain is insisted upon, complete the contract with conditioned yarn as before and mark each invoice "at old standard of regain."

C—Otherwise eliminate conditioning and invoice as follows (after gross and net calculation).

	£	s.	d.
Net <i>xx</i> lbs. @ <i>yyd.</i>
Add 5% for new standard regain (drier yarn)
	—	—	—
	—	—	—

Counts delivered at new standard DD equals old standard CC
(See table of counts.)

Those who actually determine the moisture content and allowance for each delivery will continue to do so, but on the new standard.

D—Allow for the increased sinkage from top to yarn in quoting under the new standard of condition.

A table of the new and old counts appears at the end of this section.

Yarn Merchants take similar steps with their customers and arrange with spinners accordingly. (Note that export or other deliveries already "unconditioned" will not be altered except for the *nominal* count.)

Top Makers take similar steps as regards *tops in oil*, not dry tops. The amount to be added to invoice will only be 0.63% (not 5% as is the case with yarn).

Example—119 lbs. of tops in oil at the old regain at 100d. per lb. is worth 11,900d. and contains 100 lbs. of dry material.

At the new regain the value will be the same, but the weight only 118½ lbs. Therefore the price per lb. is 11,900d. ÷ 118½ (=100.633d.), that is 100.63d.

Repeat Orders should always be made, accepted and invoiced, with the addition of the words "at the new regain of 12.62%," and in the case of yarn add—"Count CC at new regain equals DD at old regain." (See table.)

New Orders and Invoices—For a period of six months, as a precaution, the same steps should be taken as for repeat orders.

Manufacturers, Designers, and Users of Yarn—For repeating old cloths and designing new, yarn will have to be ordered 5% higher nominal count, see table. Orders should be worded "Count DD at the new regain."

Hosiery Manufacturers—So far as ordering &c. is concerned, they will take the same steps as other manufacturers. Some who do not use a lubricating emulsion may require condition added, and would order, say, "3% of moisture to be added above the standard." Alternatively, the yarn will gain moisture from the air up to about 15 to 16% regain, besides improving in other respects, if stored for a fortnight in a cool place. It may be noted that, whereas on the old standard of 18½% finished goods were generally

less in weight than the yarn purchased, under the new standard there will rather be a gain. The actual cost will be the same, as the drier yarn will be a little dearer.

Table of Equivalent Nominal Counts (Worsted)

CC Nominal Count at Old Regain of 18.25%					DD Nominal Count at New Regain of 12.62%				
1.00	1.05	
2.00	2.10	
3.00	3.15	
4.00	4.2	
5.00	5.25	
6.00	6.30	
7.00	7.35	
8.00	8.40	
9.00	9.45	
10	10.5	
12	12.6	
15	15.75	
16	16.80	
18	18.90	
20	21	
22	23.1	
24	25.2	
25	26.25	
30	31.5	
32	33.6	
36	37.8	
40	42	
44	46.2	
48	50.4	
50	52.5	
60	63	
70	73.5	
80	84	
90	94.5	
100	105	

Formulae—If old count is C and new count D

$$\text{Then } D = C + \frac{5}{100}C$$

$$\text{And } C = \frac{100}{105}D$$

